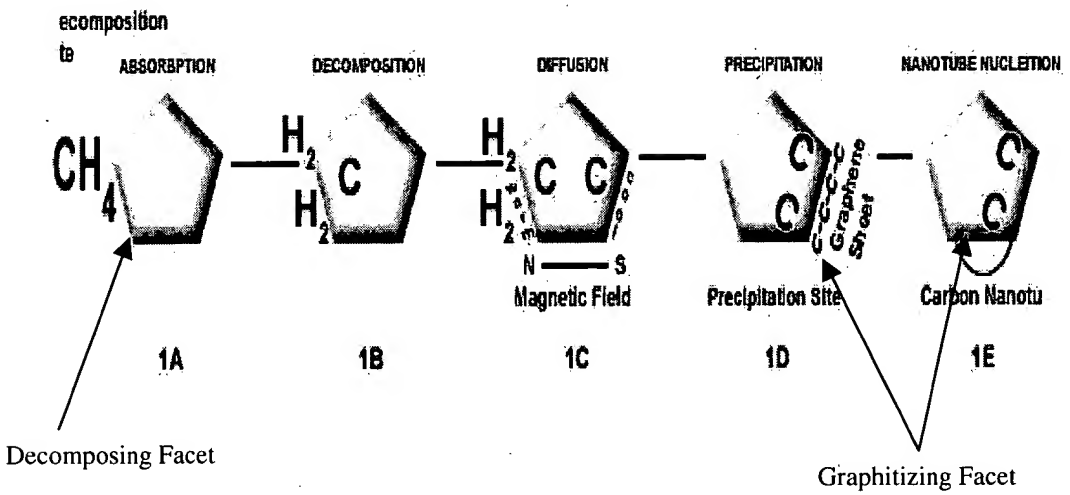
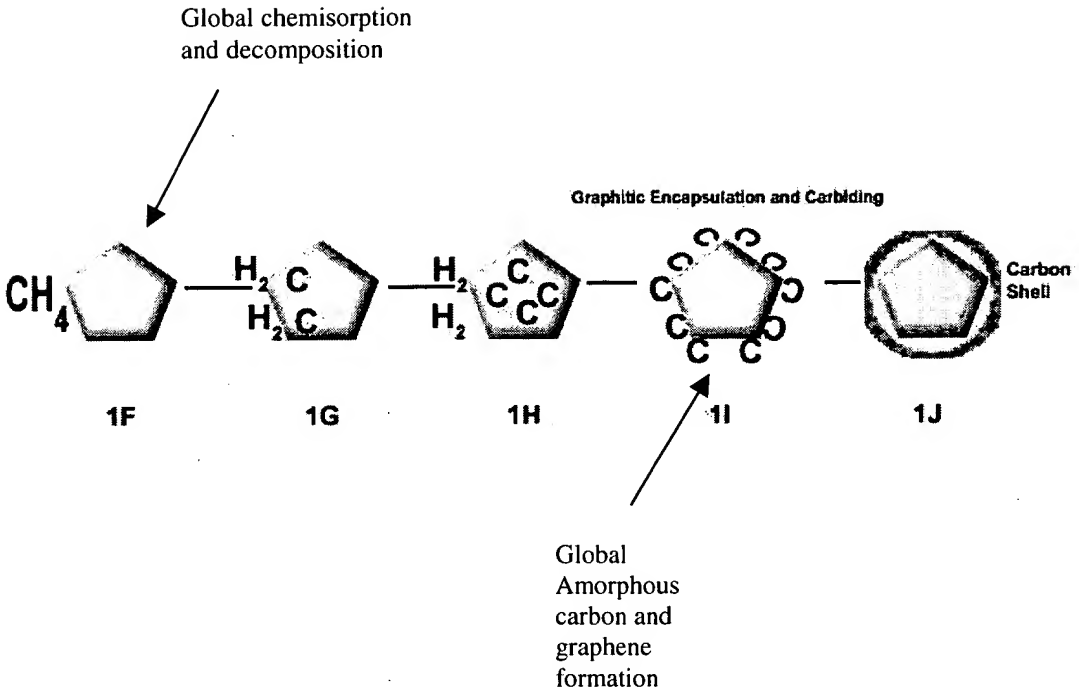
Figures 1A-1E



Decomposing Facet

Graphitizing Facet

Figures 1F-1J



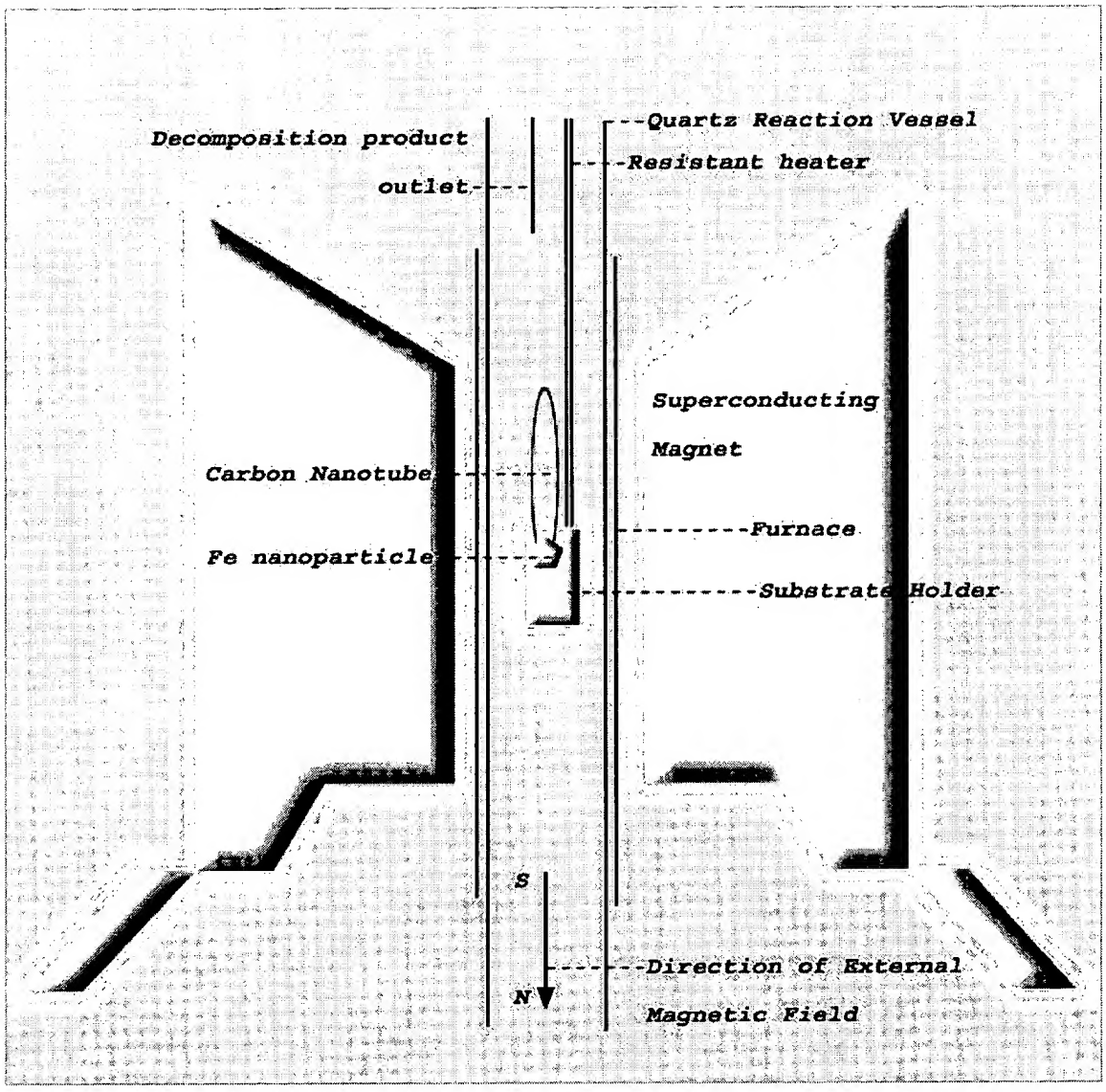


Figure 2 - Magneto Catalytic Chemical Vapor Deposition Reactor

Figure 3

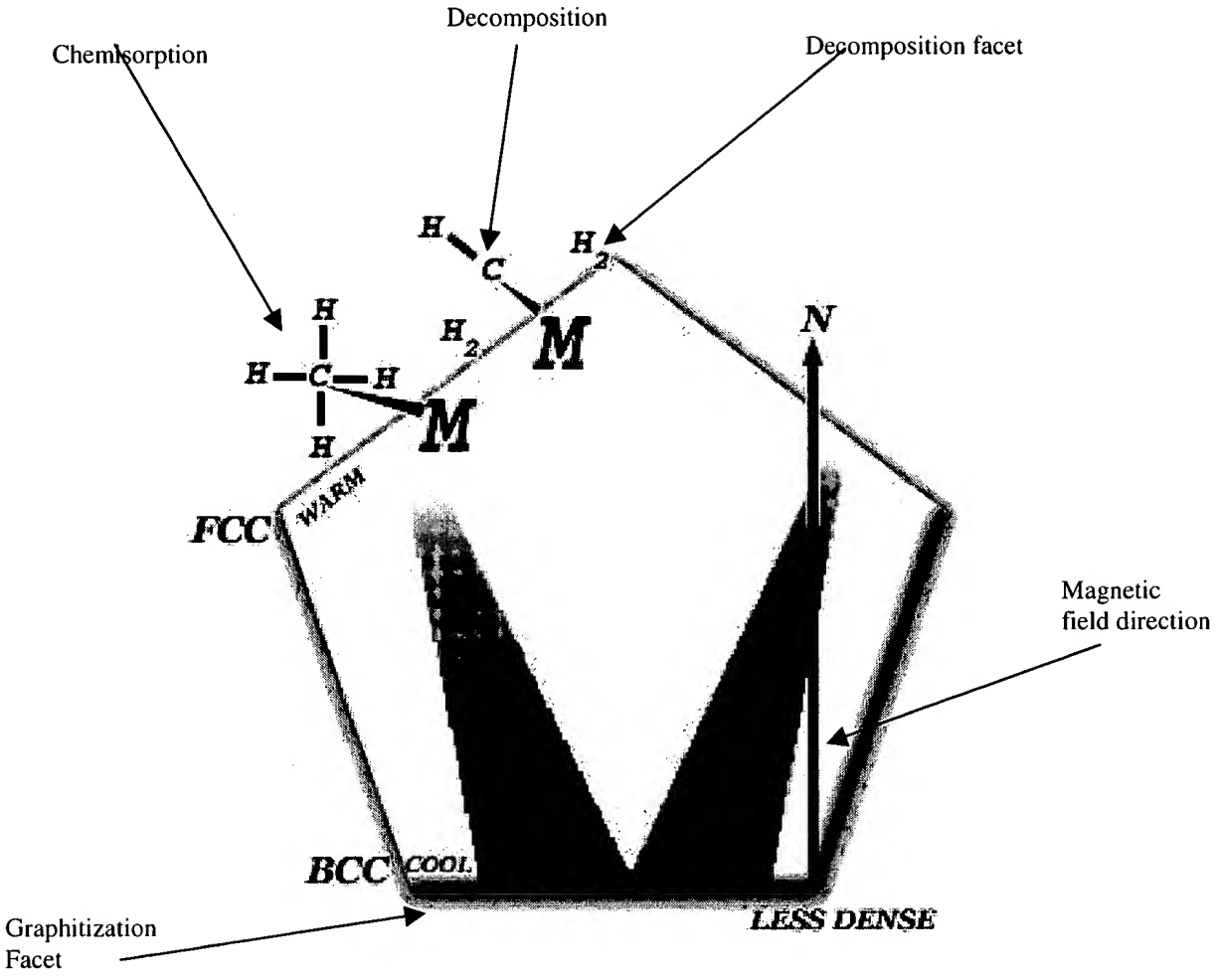

Chemisorption
Decomposition
Decomposition facet
H
C
H2
M
N
H
H—C—H
H
M
FCC
WARM
Magnetic
field direction
BCC
COOL
LESS DENSE
Graphitization
Facet

Figure 4

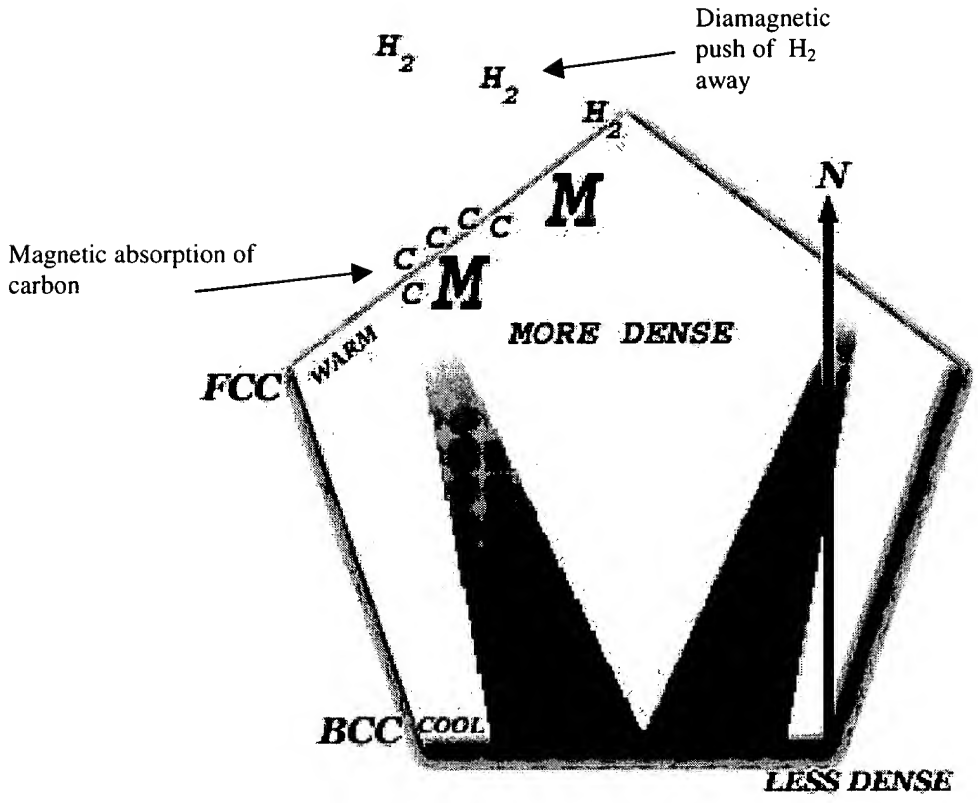

Diamagnetic
push of H_2
away
H_2
H_2
H_2
M
N
Magnetic absorption of
carbon
C C C C
C C M
MORE DENSE
FCC
WARM
BCC
COOL
LESS DENSE

Figure 5

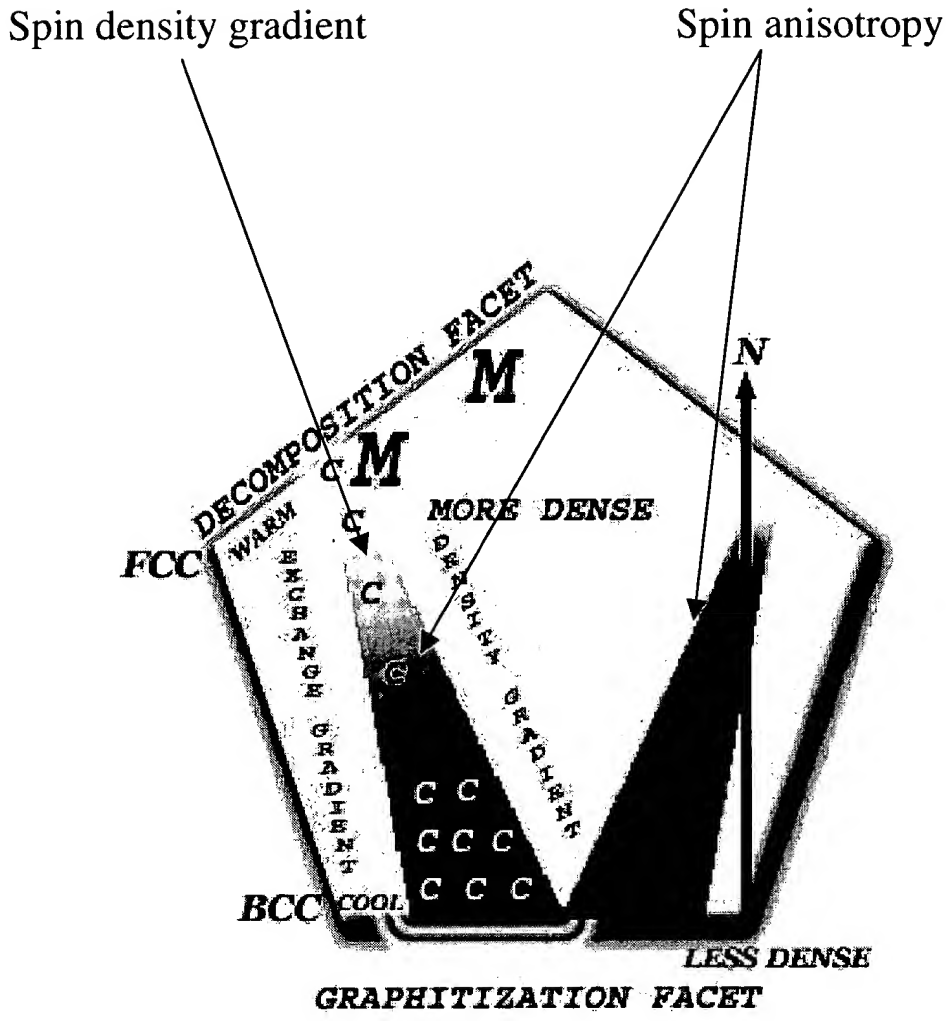
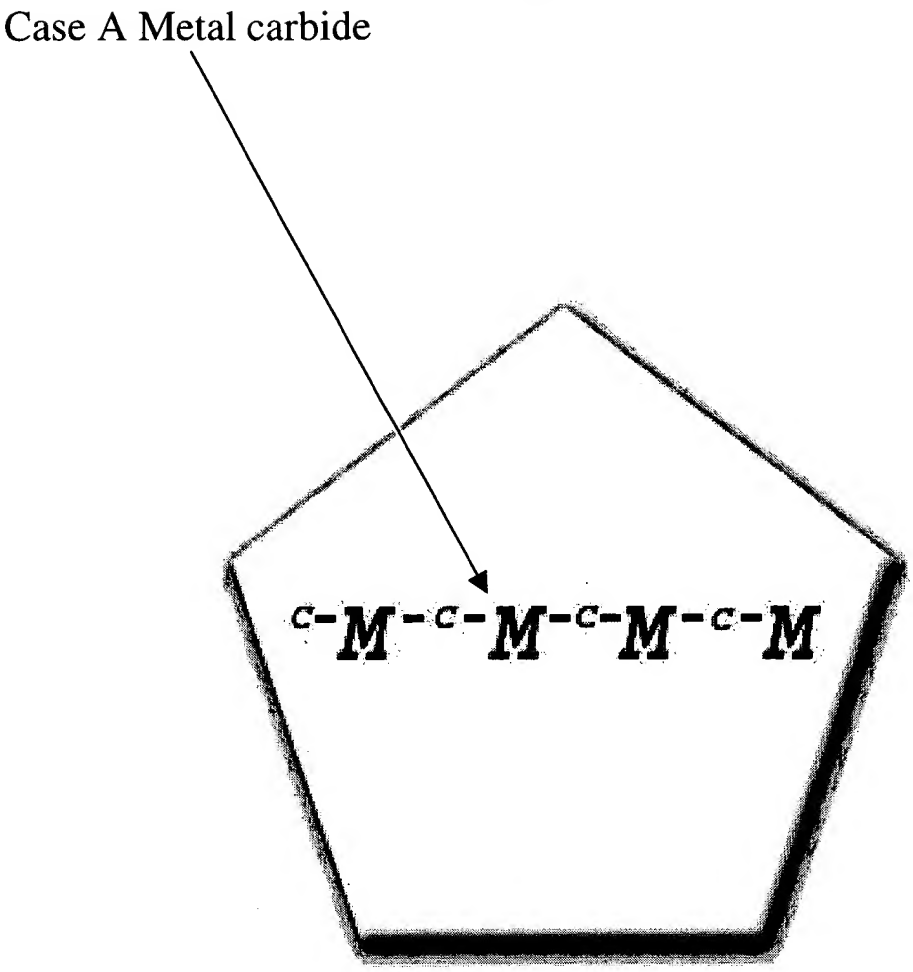

Spin density gradient
Spin anisotropy
DECOMPOSITION FACET
M
M
N
FCC
WARM
MORE DENSE
EXCHANGE GRADIENT
DENSITY GRADIENT
C
C C
C C C
C C C
BCC
COOL
LESS DENSE
GRAPHITIZATION FACET

Figure 6



B1- Metastable Metal Carbide

Figure 7

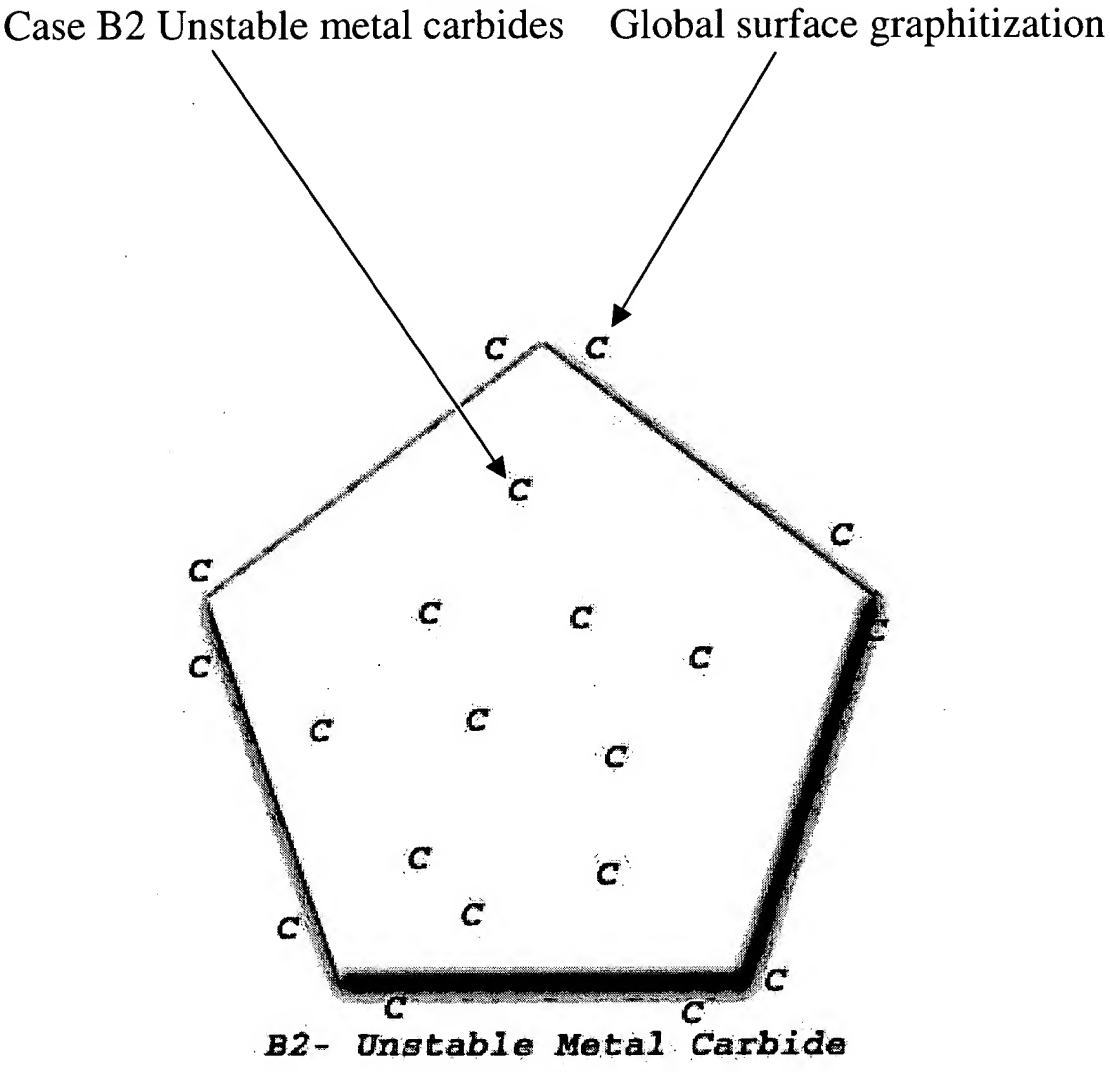

Case B2 Unstable metal carbides
Global surface graphitization
B2- Unstable Metal Carbide

Figure 8

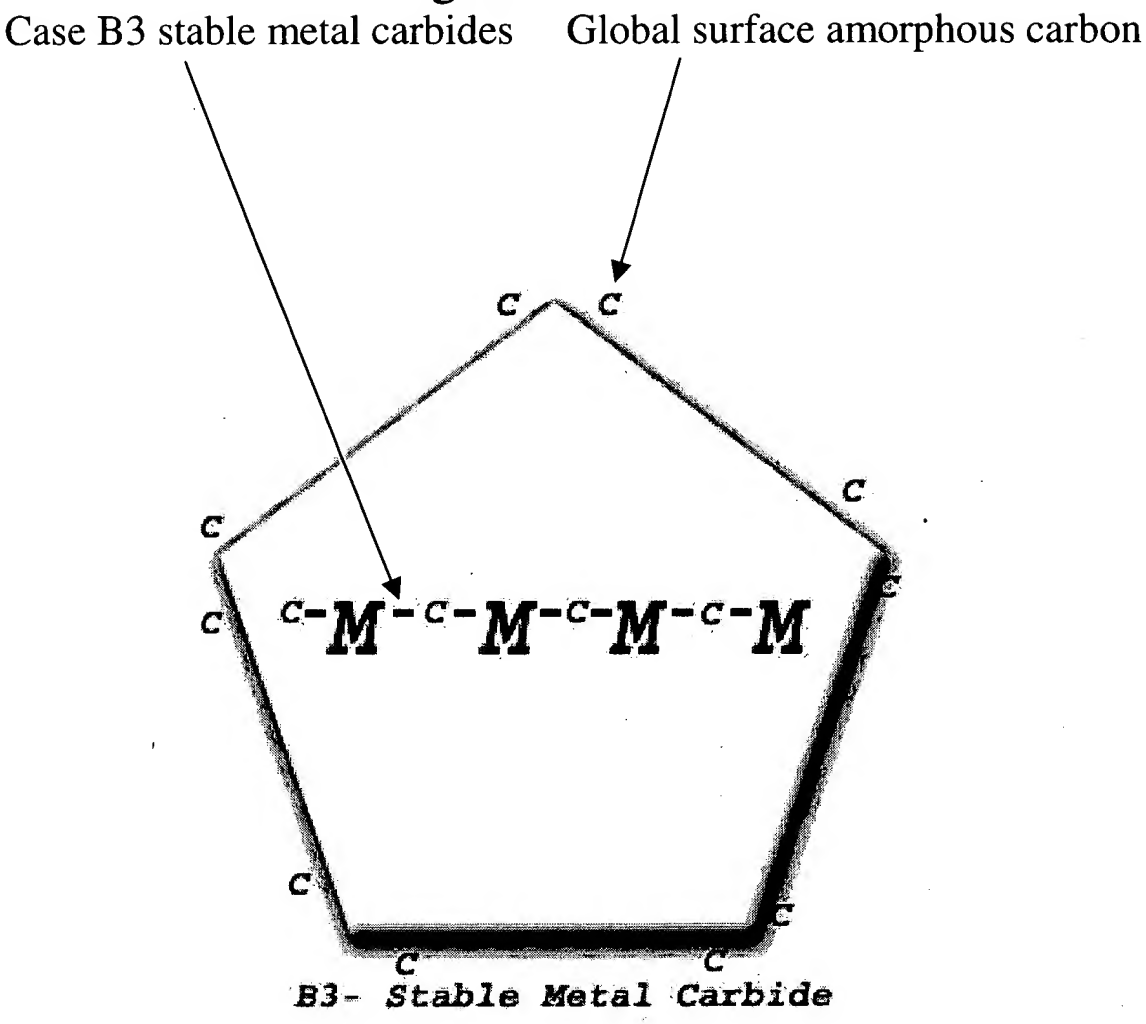

Case B3 stable metal carbides
Global surface amorphous carbon
C
C
C
C
C
C-M-C-M-C-M-C-M
C
C
C
C
B3- Stable Metal Carbide

Figure 9

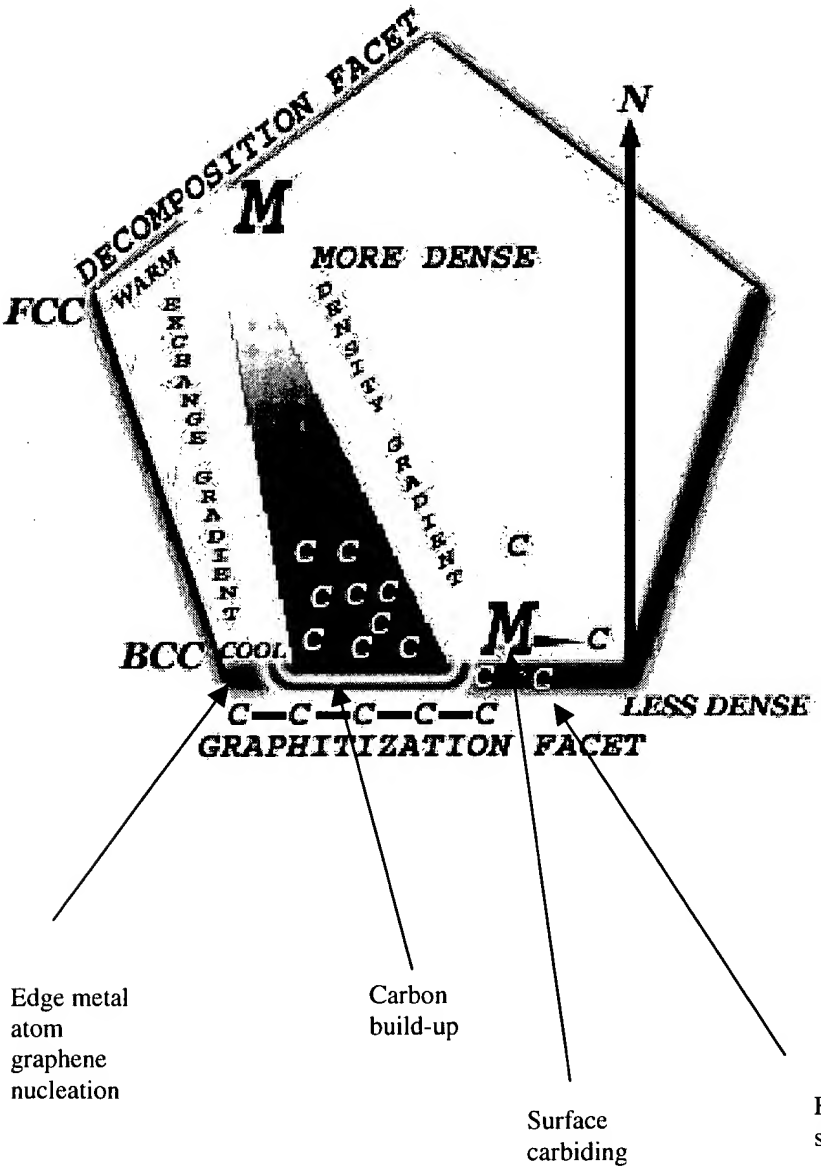
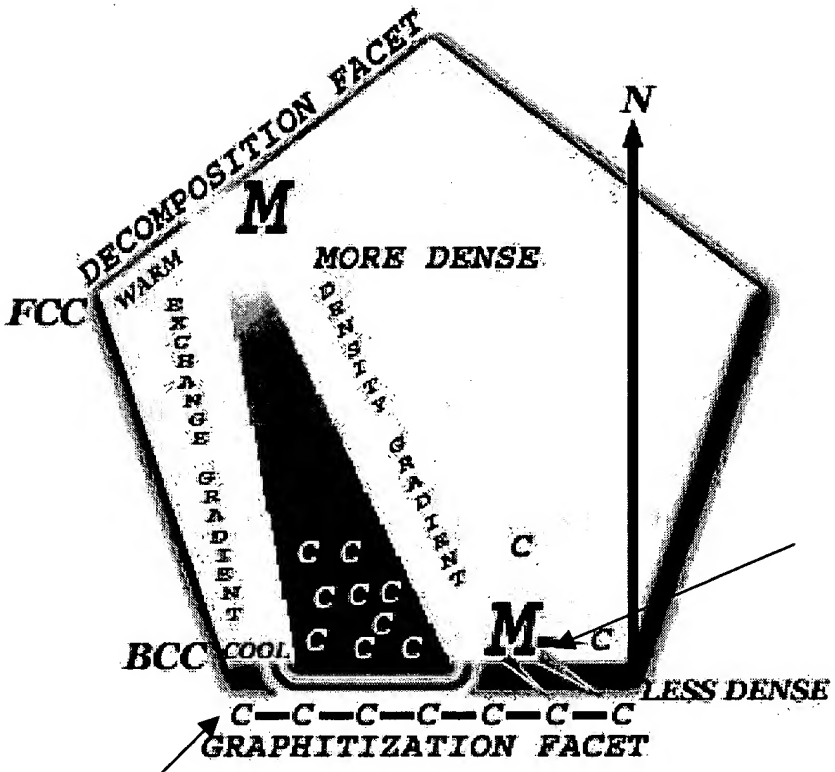

DECOMPOSITION FACET
M
N
MORE DENSE
FCC
WARM
EXCHANGE GRADIENT
DENSITY GRADIENT
C C
C C C
C C C
C
M—C
C C
BCC
COOL
C—C—C—C—C
LESS DENSE
GRAPHITIZATION FACET
Edge metal atom graphene nucleation
Carbon build-up
Surface carbiding
Exchange stabilization

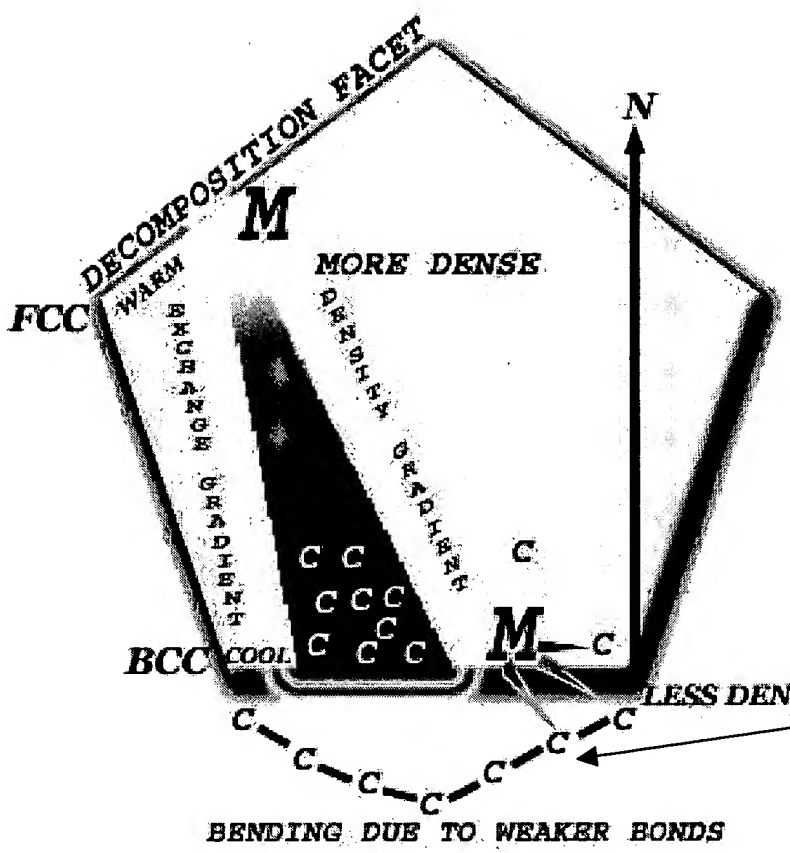
Figure 10



chemisorption and graphene bond weakening

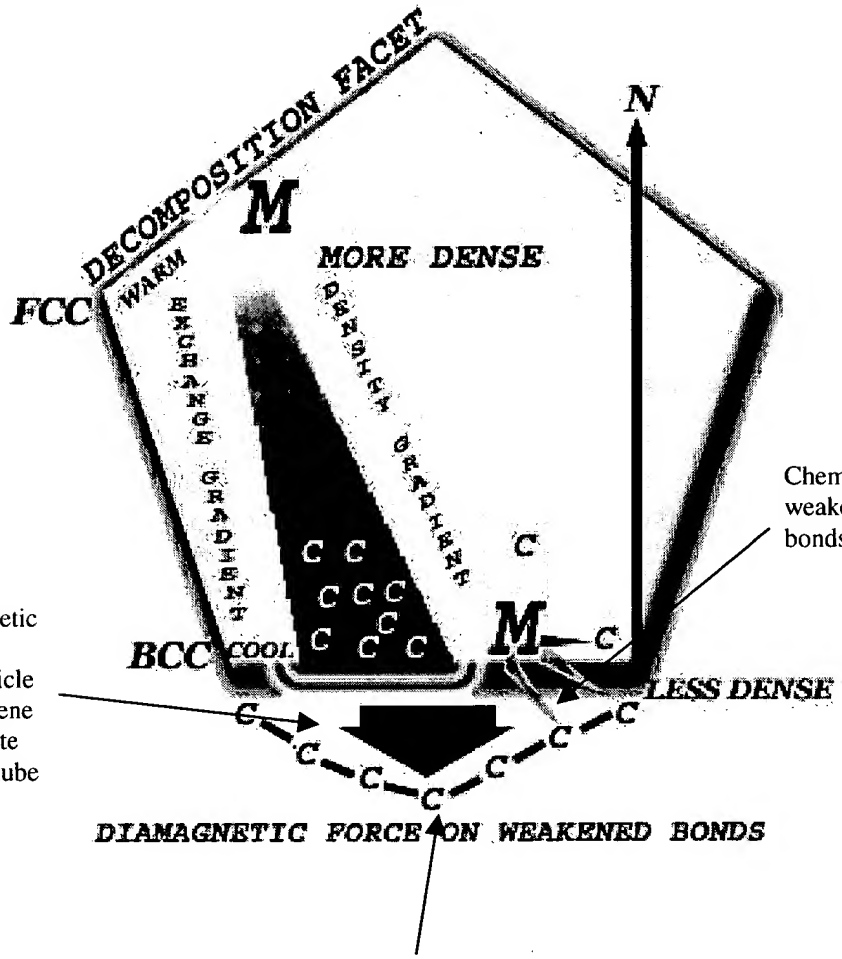
Parallel graphene sheet

Figure 11



Nanoparticle diamagnetic phonon induced concerted distortion of graphene

Figure 12



Chemisorption weakens graphene bonds

Diamagnetic force of nanoparticle on graphene to nucleate the nanotube

Distortion of parallel graphene sheet into nanotube

Figure 13

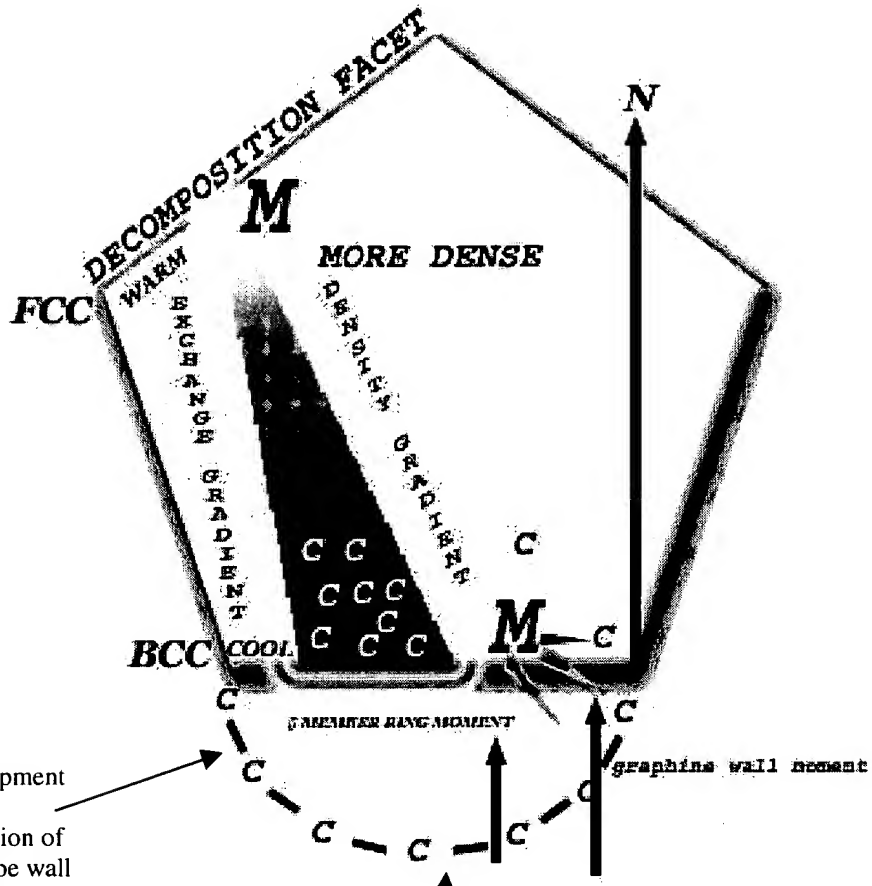

DECOMPOSITION FACET
M
N
MORE DENSE
FCC
WARM
EXCHANGE GRADIENT
DENSITY GRADIENT
C C
C C C
C
C C C
C
M
C
BCC
COOL
C
C
graphine wall moment
C
C
C
C
C
C
Development and elongation of nanotube wall or normal graphene structure
Development of nanotubular dome containing graphene and five member rings

Figure 14

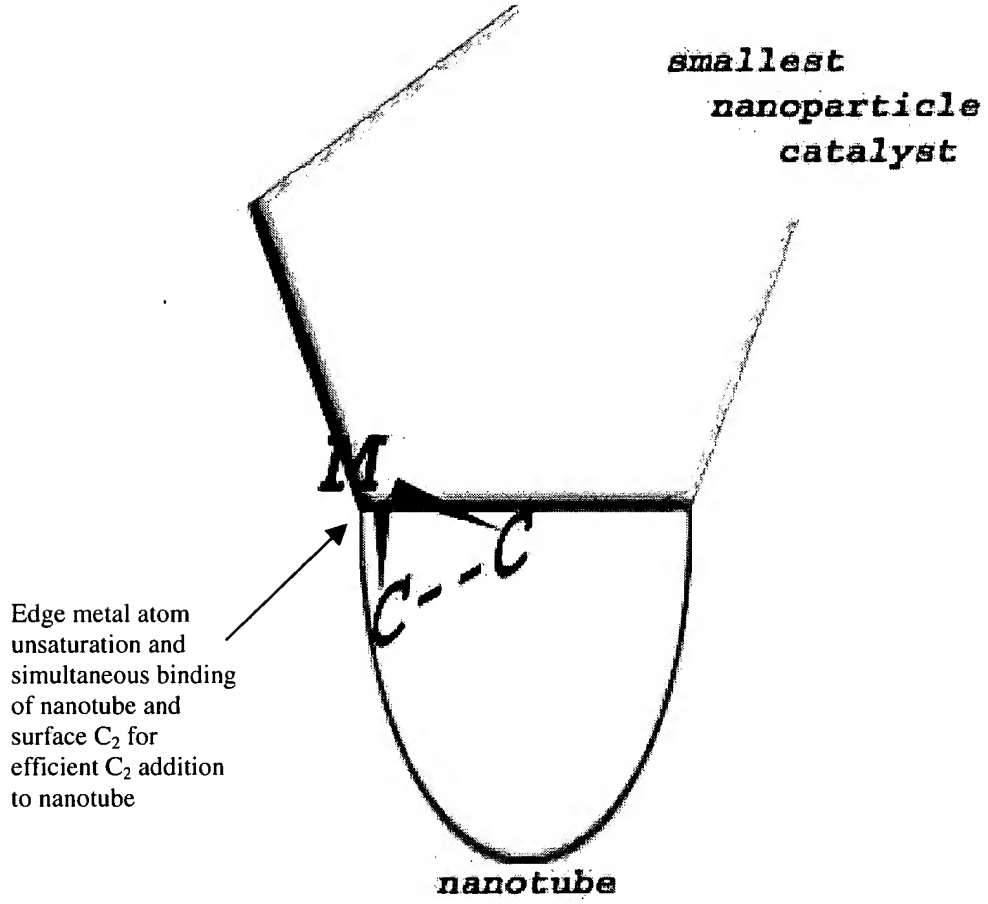

smallest
nanoparticle
catalyst
M
C--C
Edge metal atom
unsaturation and
simultaneous binding
of nanotube and
surface C_2 for
efficient C_2 addition
to nanotube
nanotube

Figure 15

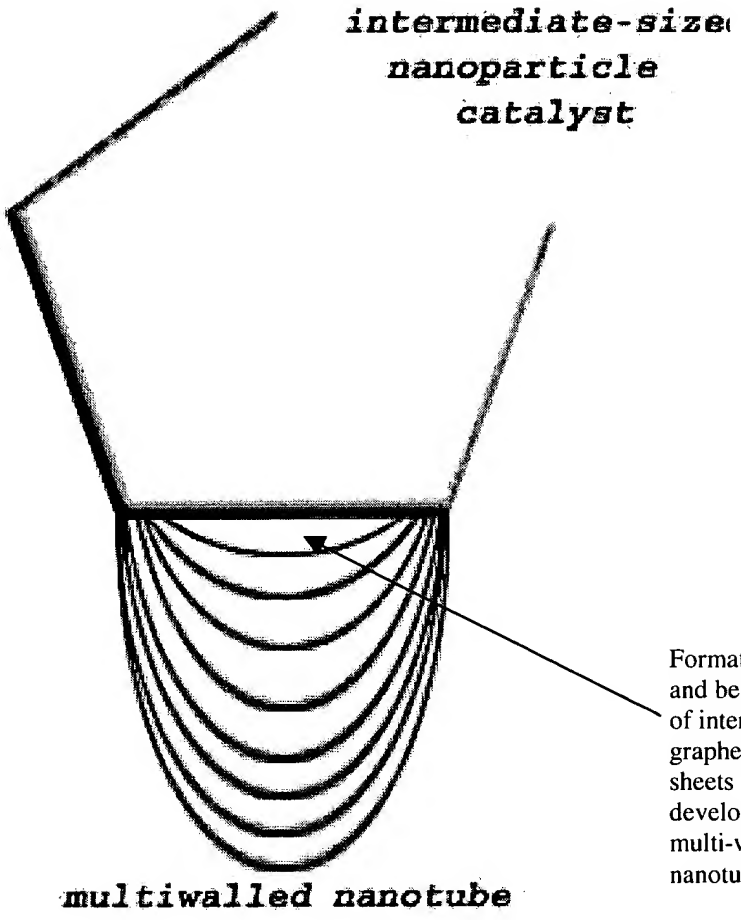

intermediate-size
nanoparticle
catalyst
Formation and bending of internal graphene sheets to develop the multi-walled nanotube
multiwalled nanotube

Figure 16

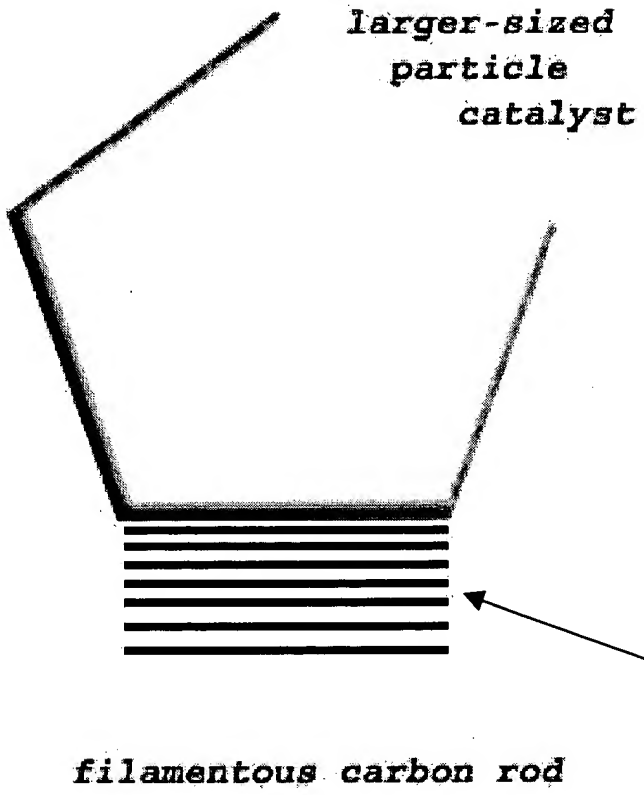

larger-sized
particle
catalyst
filamentous carbon rod
Bending in-ability of large graphene sheets and the development of solid filamentous carbon rods

Figure 17 – Magneto Catalytic Chemical Vapor Deposition System

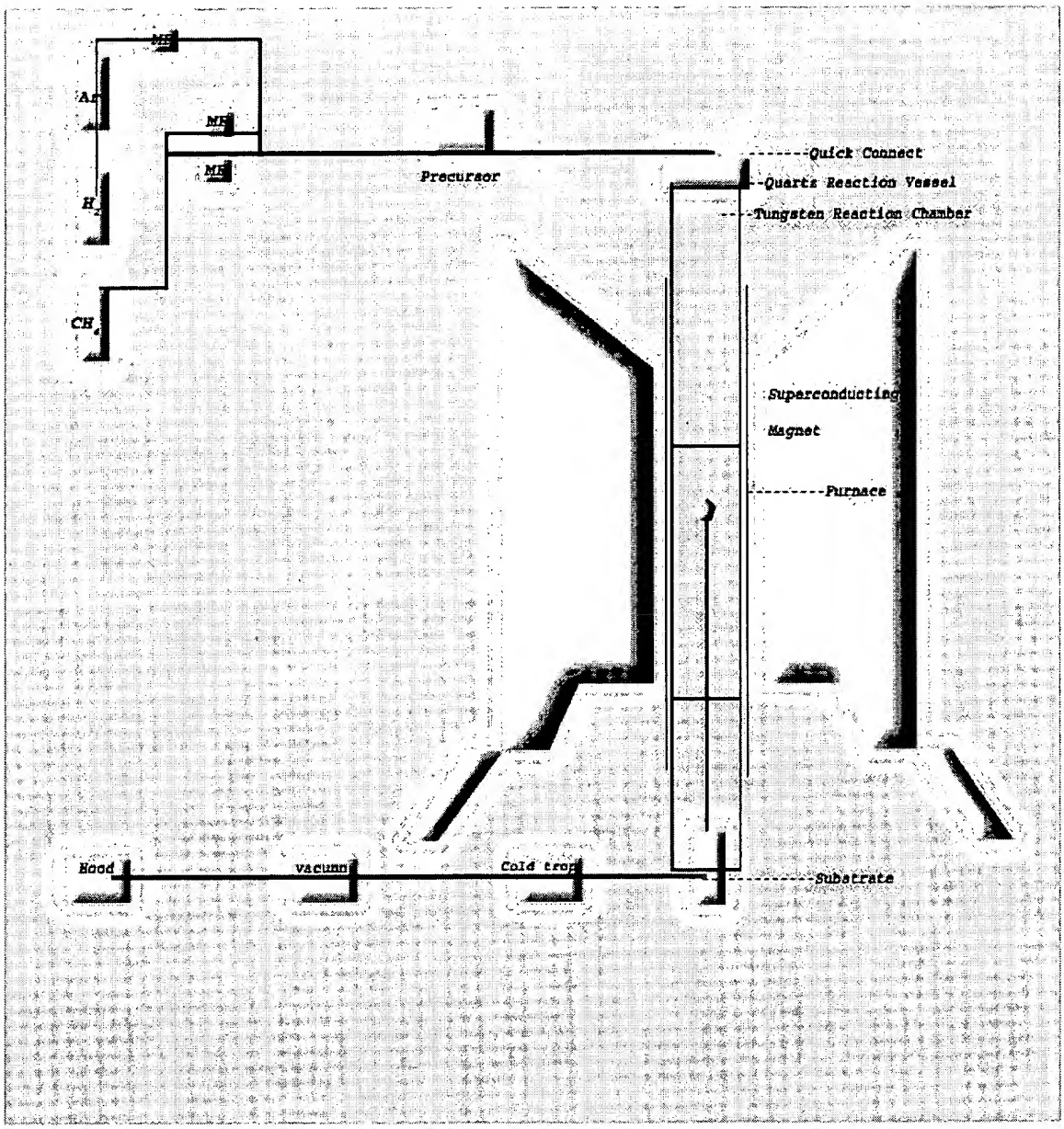
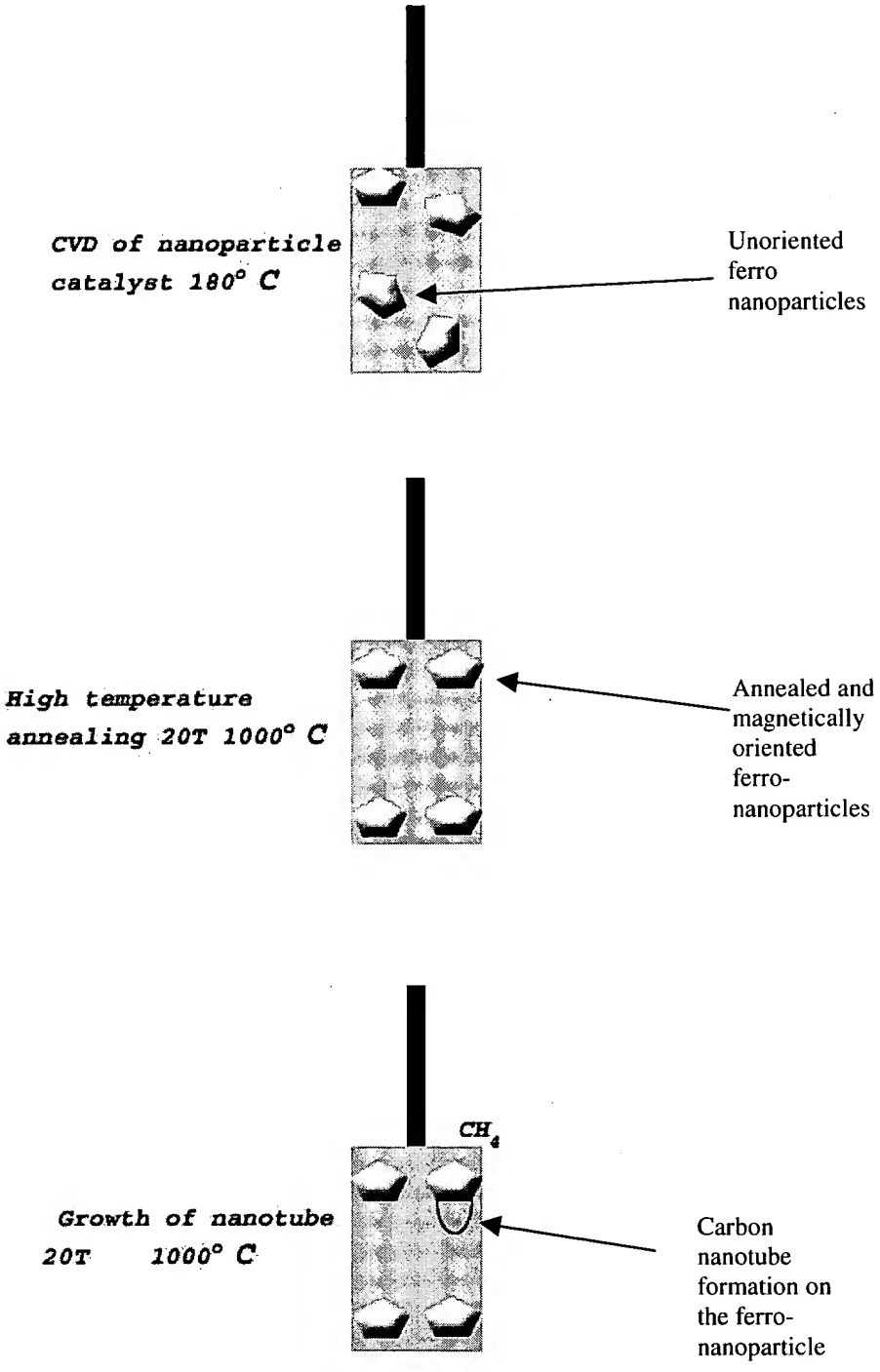


Figure 18


CVD of nanoparticle catalyst 180° C
Unoriented ferro nanoparticles
High temperature annealing 20T 1000° C
Annealed and magnetically oriented ferro-nanoparticles
CH4
Growth of nanotube 20T 1000° C
Carbon nanotube formation on the ferro-nanoparticle